no portion of the conductor should ever be allowed to attain a temperature exceeding 150° F.

8. Under ordinary circumstances complete metallic circuits should be used; the employment of gas or water pipes as conductors for the purpose of completing the circuit should not in any case be allowed.

9. Bare wires passing over the tops of houses should never be less than seven feet clear of any part of the roof, and all wires crossing thoroughfares should invariably be high enough to allow fire-escapes to pass under them.

10. It is most essential that joints should be electrically and mechanically perfect and united by solder.

11. The position of wires when underground should be clearly indicated, and they should be laid down so as to be easily inspected and repaired.

12. All wires used for indoor purposes should be efficiently insulated, either by being covered throughout with some insulating medium, or, if bare, by resting on insulated supports.

13. When these wires pass through roofs, floors, walls, or partitions, or where they cross or are liable to touch metallic masses, like iron girders or pipes, they should be thoroughly protected by suitable additional covering; and where they are liable to abrasion from any cause, or to the depredations of rats or mice, they should be efficiently incased in some hard material.

14. Where indoor wires are put out of sight, as beneath flooring, they should be thoroughly protected from mechanical injury, and their position should be indicated.

N.B.—The value of frequently testing the apparatus and circuits cannot be too strongly urged. The escape of electricity cannot be detected by the sense of smell, as can gas, but it can be detected by apparatus far more certain and delicate. Leakage not only means waste, but in the presence of moisture it means destruction of the conductor and its insulating covering, by electric action.

III. LAMPS

15. Arc lamps should always be guarded by proper lanterns to prevent danger from falling incandescent pieces of carbon, and from ascending sparks. Their globes should be protected with wire netting.

16. The lanterns, and all parts which are to be handled, should be insulated from the circuit.

IV. DANGER TO PERSON

17. Where bare wire out of doors rests on insulating supports, it should be coated with insulating material, such as india-rubber tape or tube, for at least two feet on each side of the support.

18. To secure persons from danger inside buildings, it is essential so to arrange and protect the conductors and fittings that no one can be exposed to the shocks of alternating currents of a mean electromotive force exceeding 100 volts, or to continuous currents of 200 volts.

19. If the difference of potential within any house exceeds 200 volts, the house should be provided with a "switch," so arranged that the supply of electricity can be at once cut off.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Dr. Humphry has formally resigned the Professorship of Anatomy, after having taught anatomy in the University for thirty-six years, at first as assistant to Prof. Clark, and since 1866 as Professor. The Electoral Board for the Professorship consists of Professors Huxley, Allen, Thompson, Flower, Paget, Newton, and Liveing, Dr. Michael Foster, and Mr. J. W. Clark.

The Honorary Degree of LL.D. will be conferred in June upon Count Menabrea, formerly Italian Ambassador to England, Prof. Pasteur, Prof. Michaelis (Strasburg), Sir A. Grant, Bart., Principal of Edinburgh University, Sir John Lubbock, Bart., Sir J. A. G. Ouseley, Bart., Professor of Music at Oxford, Sir Richard Temple, Bart., Lieut.-Gen. Walker, Surveyor-General of India, Mr. Matthew Arnold, Prof. W. W. Goodwin (Harvard, U.S.), Mr. Reginald S. Poole (British Museum), Prof. H. E. Roscoe (Owens College), and Mr. G. F. Watts, R.A.

The Graces creating a Professorship of Surgery without stipend, and authorising the immediate appointment of a Professor of Physiology, are to be voted on to-day (Thursday).

THE City and Guilds of London Institute has decided to make a grant of 300*l.* a year for five years, for the purpose of supporting a Chair of Mechanical Engineering in connection with Firth College, Sheffield.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 15.—"Atmospheric Absorption in the Infra-Red of the Solar Spectrum." By Capt. Abney, R.E., F.R.S., and Lieut.-Col. Festing, R.E.

Any investigations on the subject of atmospheric absorption are of such importance in the study of meteorology, that we have deemed it advisable to present a preliminary notice of certain results obtained by us, without waiting to present a more detailed account which will be communicated at a future date. From 1874, when one of us commenced photographing the spectrum in the above region, till more than a year ago, the extremely various manners in which the absorption took place caused considerable perplexity as to their origin, and it was only after we had completed our paper on the absorption of certain liquids [1] that a clue to the phenomena was apparently found. Since that time we have carefully watched the spectrum in relation to atmospheric moisture, and we think that more than a year's observations in London, when taken in connection with a month's work at an altitude of 8500 feet on the Riffel, justify the conclusions we now lay before the Society.

A study of the map of the infra-red region of the solar spectrum,[2] and more especially a new and much more complete one, which is being prepared for presentation to the Royal Society by one of us, shows that the spectrum in this part is traversed by absorption lines of various intensities. Besides these linear absorptions, photographs taken on days of different atmospheric condition show banded absorptions superposed over them. These latter are step by step absorptions increasing in intensity as they approach the limit of the spectrum at the least refrangible end. In the annexed diagram [3] Fig. 4 shows the general appearance of this region up to λ 10,000 on a fairly dry day: the banded absorption is small, taking place principally between λ 9420 and λ 9800: a trace of absorption is also visible between λ 8330 and λ 9420. On a cold day, with a north-easterly wind blowing, and also at a high altitude on a dry day, these absorptions nearly if not quite disappear. If we examine photographs taken when the air is nearly saturated with moisture (in some form or another) we have a spectrum like Fig. 1. Except with very prolonged exposure no trace of a spectrum below λ 8330 can be photographed. Fig. 2 shows the absorption-bands, where there is a difference of about 3° between the wet and dry bulbs, the latter standing at about 50°. It will be noticed that the spectrum extends to the limit of about λ 9420, when total absorption steps in and blocks out the rest of the spectrum. Fig. 3 shows the spectrum where the difference between the wet and the dry bulbs is about 6°. Figs. 5 and 6 show the absorption of thicknesses of 1 foot and 3 inches of water respectively, where the source of light gives a continuous spectrum. With ⅛-inch of water all absorption-bands except that commencing at λ 9420 are absent. It will be seen that there is an accurate coincidence between these "water-bands" and the absorption-bands seen in the solar spectrum, and hence we cannot but assume that there is a connection one with the other. In fact, on a dry day it is only necessary to place varying thicknesses of water before the slit of the spectroscope and to photograph the solar spectrum through them, in order to reproduce the phenomena observed on days in which there is more or less moisture present in the atmosphere. It is quite easy to deduce the moisture present in atmosphere at certain temperatures by a study of the photographs. There does appear a difference, however, in the intensity of the banded absorptions in hot weather and in cold about up to 50°. In the former they are less marked when the degree of saturation and the length of atmosphere traversed are the same as in the latter.

The accepted view, we believe, of absorption of vapours is that they give linear absorptions in certain thicknesses, and as the thickness increases or the density becomes greater, the lines blacken, new lines appear, and gradually total absorption sets in in the region where the lines are most numerous and close. It is in the range of possibility that the presence of a small quantity of vapour might show itself as a haze over some region of the spectrum; if, however, the quantity was gradually increased, the haze would give place to lines, and the phenomena just described would be repeated. Suppose several localities of absorption to exist, the absorptive power of the vapour increasing the further down in the infra-red the locality was situated, it might happen that, whilst one locality showed only a haze of absorption, one further down might show total absorption, and some locality between these two should show linear absorption.

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[1] "The Influence of the Atomic Groupings of the Molecules of Organic Bodies on their Absorption in the Infra-Red Region of the Spectrum." *Phil. Trans.*, Part III., 1881.

[2] *Phil. Trans.*, 1880.

[3] The black lines given in the diagram are merely lines of reference, and do not represent the aqueous absorption under consideration.

In the case of the absorptions in the solar spectrum we find a very different state of things existing. A comparison of the photographs taken in London on days of different dryness, and with those taken at the Riffel, shows that the linear absorptions are not increased in number or intensity; except so far that the blackness of the lines is increased by the blackness of the banded absorptions, and the same blackness can be induced by placing a certain thickness of water before the slit of the spectroscope: another point is that the Fraunhofer lines in certain regions (say λ 9420 to λ 9800) are so irregularly distributed as to preclude the idea that they all belong to the absorption of aqueous vapour, yet all are equally darkened by the band, and they do not spread out as the blackness of the band increases. This is against the view of the bands being formed by aqueous vapour, as we know it.

The question then arises as to what these "water-bands" can be due—if not due to vapour. This we consider an open question, and one which should be discussed. All we can state is that the absorptions shown are similar to those of water (liquid) and they do not seem to point to the watery stuff existing as vapour,[1] if we take the visible spectrum as a guide. An intense blue sky at sea-level is often indicative of moisture in the atmosphere, and it also seems to be indicative of finely suspended matter of some kind. If this be the case, can this suspended matter be suspended water stuff? for if it be not, there is no reason why the sky should be bluer on a moist day than on a dry day. We would remark that the deep blue sky at sea-level is of a different colour to the black-blue of high altitudes where, if they exist, the fine suspended particles would be largely diminished in number, and the coarser particles which cause white haze would also be fewer. The great difference of the intensities of the light from the blue sky in England and at 10,000 feet was determined by one of us and communicated to the British Association at Southampton, and the enormous disparity between the two has some bearing on the question we have been discussing.

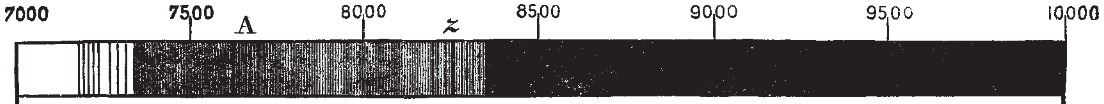

FIG. 1.

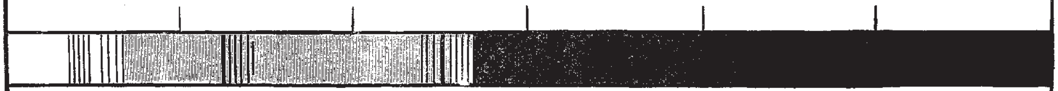

FIG. 2.

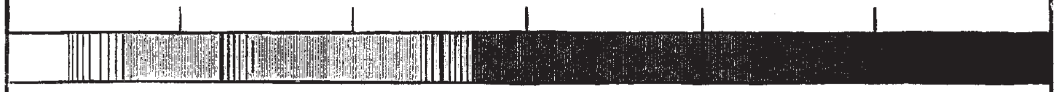

FIG. 3.

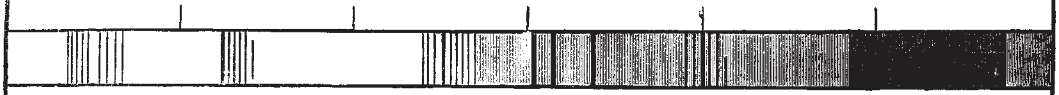

FIG. 4.

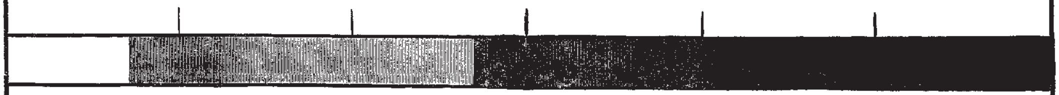

FIG. 5.

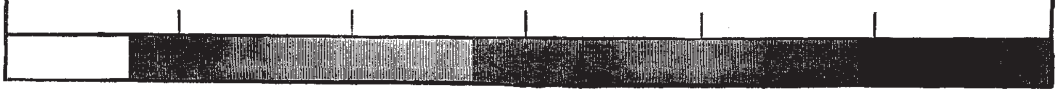

FIG. 6.

In the above paper we have described the absorption due to "water stuff" in the atmosphere to λ 9800, as it is only to that wave-length to which the normal spectrum has been as yet published. We wish however to add that there are bands in the solar spectrum commencing at[1] λ 9800, λ 12,200, and λ 15,200, and giving step by step absorptions from one wave-length to the next, as in the diagram, which also corresponds with *cold* water bands. The absorption in the locality from 12,200 downwards is usually total, and it is only on dry cold days or at high altitudes that rays of sufficient amplitude can penetrate to cause photographic impression to be made.

April 5.—"Observations on the Colouring-matters of the so-called Bile of Invertebrates, on those of the Bile of Vertebrates, and on some unusual Urine Pigments, &c.," by Charles A. MacMunn, B.A., M.D. Communicated by Dr. M. Foster, Sec.R.S.

In this paper the result of a systematic examination of the bile and various extracts of the so-called liver of Mollusca and Arthropoda, and of the pyloric or radial cœca and other appendages of the digestive system of Echinodermata is described. The universal distribution of one colouring-matter, which by appropriate experiments is shown to be a chlorophyll pigment, is proved. It occurs in the above organs, and can be detected in the bile of specimens of *Helix* after a six months' fast; for this colouring-matter, since it is found in the appendages of the enteron, the name enterochlorophyll is proposed. The slight differences observable in different cases are shown to be due to the probable greater or less amount of the usual chlorophyll constituents, blue chlorophyll, yellow chlorophyll, and chlorofucine, and the presence of xanthophyll, lutein, or tetronerythrin. Enterochlorophyll is shown to be much more abundant in the liver of Mollusca and in Echinodermata than in Crustacea, as the livers of the last generally contain more lutein, or sometimes tetronerythrin may be present.

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[1] These wave-lengths are taken from the map from the *Phil. Trans.*, 1880, and are only to be considered approximate.

[1] Unless it be held that the water itself holds vapour in solution.

The presence of reduced hæmatin is also demonstrated in the bile of the crayfish and in several pulmonate Mollusca, and its respiratory and other uses discussed.

The conclusions which these observations and others led to are summed up as follows :—

(1.) The existence of enterochlorophyll in the so-called liver, or other appendages of the enteron in Invertebrates is definitely established.

(2.) This pigment occurs in greatest abundance in Mollusca, it occurs less frequently in Arthropoda, and its presence in Vermes is not proved.

(3.) The pyloric cœca of starfishes contain it in great abundance, also the intestinal appendages of *Echinus*, which fact shows that the former function like the so-called liver of other Invertebrates.

(4.) The bile of the crayfish and that of most pulmonate Mollusca contains hæmochromogen ; in the latter it is generally accompanied by enterochlorophyll, and appears to be concerned more in aërial than aquatic respiration.

(5.) The so-called liver of Invertebrates is a pigment-producing and storing organ, as well as being concerned in the preparation of a digestive ferment.

(6.) The presence of hæmochromogen in the bile of Invertebrates is apparently determined by their mode of living, and it does not appear to be distributed according to purely morphological considerations.

The remainder of the paper deals with vertebrate bile pigments, and contains some observations on abnormal urinary colouring matters, mainly with regard to their spectroscopy. The various bile pigments of Städeler are first dealt with, and some remarks on the bile spectra of animals follow ; here it is shown that urobilin can be extracted from the liver of *Salamandra maculata* by means of alcohol, that it is absent from reptilian bile during hibernation, and that the liver of some fishes may contain tetronerythrin which can be extracted from them by suitable solvents. The latter fact suggests an analogous function to that of the liver of Invertebrata.

The results of the examination of a green hydrocele liquid are detailed, which showed beyond doubt that biliverdin was present, and since in that case its origin could be traced to blood pigment, the origin of biliverdin from blood pigment is demonstrated.

The identity of stercobilin and hydrobilirubin got by the action of nascent hydrogen on bilirubin is proved, and a difference between them and febrile urobilin shown to exist.

The statement that the absorption-bands of sheep bile are the same as those which occur in Gmelin's reaction is shown to be erroneous, and a brief description of the method of isolating the colouring-matter of sheep bile and the wave-lengths of its different solutions given. Chlorophyll is shown to be absent.

Under the head of urinary pigments it is shown that the feeble bands described by me in a former paper in the spectrum of febrile urobilin are not due to impurities, but are as much part of the spectrum as the band at F. Urohæmatin and its difference from hæmatoporphyrin and its pathological significance are discussed. A simple method for the detection of indican in urine, some remarks on uroerythrin, and on a peculiar red colouring-matter in pale urine, somewhat like urrhodin, follow. The deductions from this part of the paper cannot be very well given in the form of conclusions, and are therefore scattered throughout the paper.

A drawing of the microscopic structure of the liver of Limax, showing the enterochlorophyll within the liver cells, and maps of the most important absorption spectra described, accompany the paper. All readings are reduced to wave-lengths.

Physical Society, April 28.—Prof. Clifton in the chair.—A paper on colour-sensation, by Mr. H. R. Troop, was read by Mr. Walter Baily, secretary. The author showed that more than three colour-sensations were consistent with the theories of Maxwell and Helmholtz, and explained that four primary separate colour-sensations, in couples, served the theory as well as three. The author gave reasons for the existence of a fifth sensation—that of white. Mr. Stanley mentioned that his father was colour-blind to green, and saw it as a brown. He considered partial colour-blindness very common. Mr. Lewis Wright stated that he found in optical experiments a partial colour-blindness from time to time, and between one of his eyes and the other. He recommended the study of this partial and variable blindness to colours. Prof. Clifton stated that he had found similar variations amongst his students, and considered that one in three was unfit for delicate optical experiments.—Sir John Conroy exhibited a new photometer, which is a modification of Ritchie's, the white screens not meeting at an angle, but almost meeting, and one projecting a little beyond the other, so that the eye could see the outer side of one and a little of the inner side of the other, both visible surfaces being illuminated by the lights. The screens were inclosed in a blackened box.—Mr. Walter Browne then read a paper on the causes and consequences of glacier motion. After reviewing the various theories of glacier motion and criticising each, the author gave reasons for preferring that of Mr. Moseley, namely, expansion by heat. He showed that the regelation theory now commonly accepted appears inadequate, inasmuch as it does not explain the state of flow at low temperatures. Mr. Stanley pointed out that Forbes in his work on Norway gives expansion as a cause of glacier motion. Prof. Perry referred to the experiment of Mr. Bottomley (in which a wire, weighted at the ends, cuts its way through a block of ice) in support of the regelation theory ; and Prof. Guthrie described an experiment he had made of the same kind, using a copper wire and a silk cord of the same thickness, equally weighted, on the same block of ice. The wire cut through, but the silk did not. Prof. Ayrton explained this on the assumption that the wire conveyed heat from the air, and enabled the weighted wire to lower the temperature of the ice to the melting point, whereas the silk could not do so without more pressure, that is weight. Mr. W. Coffin referred to the ice-houses of Lake Superior, where he has seen heavy iron implements lying on blocks of ice at a low temperature, without sinking in. Sinking took place when the sun shone on the ice. Prof. G. Forbes said that below forty feet in rock variations of temperature were imperceptible, and probably it was the same with ice. Prof. Macleod, Mr. G. R. Griffiths, Mr. W. Baily, and the President also took part in the discussion.—Prof. Fuller then took the chair, and Prof. Clifton exhibited a new spectrometer of his design. In the spectrometer it is important that the axis round which the prism turns and the axis round which the telescope turns should not be inclined, and in the new instrument these axes are coincident. A single cone, turned very true, has the telescope piece, the circle, and prism plate fixed upon it.

Institution of Civil Engineers, April 24.—Mr. Brunlees, president, in the chair.—The paper read was "Resistance on Railway Curves as an Element of Danger," by Mr. John Mackenzie, Assoc. M. Inst. C.E.

BERLIN

Physiological Society, March 30.—Prof. Du Bois Reymond in the chair.—Instead of the condensed milk, which, owing to its large percentage of sugar, has not kept its place as a food for children, a preparation of milk has lately been introduced into the market from Switzerland, which is protected against fermentation and decomposition by previous cooking. Dr. A. Baginski has chosen the relation of this new infants' food to the digestive ferments as the subject of a comparative investigation, which is not as yet concluded, but which has elicited some physiologically interesting facts about the action and occurrence of these ferments. The rennet ferment is well known to act upon milk both when it is sour and when its reaction is neutral or alkaline, but the rapidity of the curdling when acted upon by the ferment is different for different temperatures. At the temperature of the room the milk curdled only after twenty or thirty minutes ; at a temperature of 20° to 25° C. the curdling was already completed in five minutes ; at from 30° to 35° C. the curdling lasted about one minute, and it took place at still higher temperatures up to 55° C. in still shorter time. On the other hand, at 60° C. and at higher temperatures the action of the rennet was delayed, and soon ceased altogether. In previously boiled milk rennet also failed to bring about curdling. The rennet ferment was found not alone in the stomach, but also in the small intestines and in several plants, *e.g.* in *Carica papaya*, in artichokes, and in figs. In other plants it was sought for in vain. Decomposition ferments had various actions upon rennet ; sometimes they destroyed its action, at other times they did not ; the former was particularly the case when the fluid was strongly alkaline. Pepsin had no disturbing influence upon the activity of the rennet, although trypsin had to a marked degree. Dr. Baginski made similar observations upon the effect of decomposition ferment, pepsin, and trypsin upon each other.—Prof.

Brieger reported upon the results of his attempts at a more accurate study and determination of the violent poisons which develop out of animal substances, and which not unfrequently bring about sudden death after eating stale cheese, stale sausage, or stale fish. Prof. Selmi made the first step towards the knowledge of these poisons by preparing powerfully acting bodies out of corpses and decomposing animal matter. These he described under the name of "ptomäin." Prof. Brieger has now investigated their occurrence in analogous substances by means of the reactions that Prof. Selmi gave for these ptomäins, and he has found, among other things, that neurin when exposed to the air very soon develops such a ptomäin, which, like the rest, kills frogs and rabbits with the symptoms of coma. If the neurin remains a long time exposed to the oxidising influence of the air, the violent poison disappears. Further, a poisonous body belonging to the same group was found in a number of artificial peptones, but not in all, and here also this substance was soon destroyed by further alterations taking place in the peptone. This fact could be quite universally established, viz. that a further progressing decomposition in dead bodies destroyed all poisonous substances. Prof. Brieger next approached the task of isolating these easily decomposable and violently poisonous bodies. He succeeded, by working on large masses of dead animal bodies with a series of chemical processes, in preserving the poison in beautiful, large, needle-shaped crystals. He has not as yet determined whether these consist of the poisonous body pure, or whether they also contain other bodies. Therefore the chemical composition of the ptomäins has not yet been certainly determined.

Paris

Academy of Sciences, April 30.—M. Blanchard in the chair.—The following papers were read:—On the reduction of the barometer and the pendulum to the sea-level, by M. Faye. While Poisson's correction for attraction of a continental mass may be suppressed, the attraction of a hill or mountain on which observations are made must not be neglected. At a station in mid-ocean, such as a volcanic or coral island, the attraction of the island must be considered. Correction for masses like the Alps or Himalayas is much more difficult.—On the pyro-electricity of quartz, by MM. Friedel and Curie. They dissent from Herr Hankel's views as to the distribution of electric tensions in crystals.—On a quaternary base derived from oxyquinoleine, by M. Wurtz.—Prolonged anæsthesia obtained by protoxide of nitrogen at normal pressure, by M. Bert. The new method he has tried on animals is to cause anæsthesia first with the pure protoxide, then give a mixture of the protoxide and oxygen (the blood then recovering the oxygen necessary to it); then the pure protoxide may be given again. Thus both asphyxia and return to sensibility are obviated. A dog was kept insensible half an hour. A mask and two caoutchouc bags are all that is necessary.—On the project of the African interior sea, by M. de Lesseps. He replies to M. Cosson.—On a theorem of partitions of complex numbers contained in a theorem of Jacobi, by Prof. Sylvester.—*Résumé* of meteorological observations made during the year 1882, at four points of Haut Rhin and the Vosges, by M. Hirn. *Inter alia*, the greatest actinometric differences do not always correspond to the most limpid skies. The slight mist or dust, which stops part of the luminous rays, does not absorb the calorific rays.—A new general formula for the development of the perturbative function, by M. Baillaud.—Observations of solar spots and faculæ at the Royal Observatory of the Roman College during the fourth quarter of 1882, by M. Tacchini. After the secondary minimum in August, the spots increased to a considerable maximum (relatively) in November, then decreased suddenly to a minimum in December. During 1882 there appears a greater activity than in 1881. The mean of faculæ is slightly greater in 1881 than in 1882.—Observations of solar protuberances, faculæ, and spots at the Royal Observatory of the Roman College, during the third and fourth quarters of 1882, by the same. The number of protuberances *per diem* was nearly the same as in the first half-year, but the height and extension were somewhat greater. The minimum was in September and October. Spots, faculæ, and protuberances were more numerous near the equator than in the previous half-year.—Observation of the transit of Venus at St. Thomas in the Antilles by the Brazilian Commission, by M. de Teffé. The third and fourth contacts were observed.—On the use of a birefringent glass in certain observations of spectrum analysis, by M. Cruls. By giving the crystal an alternative motion of rotation the extraordinary spectrum is displaced, and the eye is thus helped to see peculiarities better than if the spectrum were at rest. Again, the two spectra of a faint star may be so juxtaposed that the bright parts of the one correspond to the dark channellings of the other, so that vision is aided.—Determination of a particular class of surfaces, &c. (continued), by M. Darboux.—On continuous periodic fractions whose numerators differ from unity, by M. de Jonquières.—On the generalisation of the theorem of Fermat, by M. Lucas.—On the same, by M. Pallet.—On the groups of linear equations, by M. Poincaré.—On some double integrals, by M. Goursat.—On the Eulerian functions, by M. Bourguet.—On the cycle of motors with explosive gases, by M. Witz.—On the transmission of sound by gases, by M. Neyreneuf. With a sensitive flame arrangement he proves that carbonic oxide has about the same transmitting power as air; carbonic acid much greater. He finds Hauksbee's law inexact.—On the analogy that exists between the allotropic states of phosphorus and of arsenic, by M. Engel.—Research on the metallic derivatives of amides; means of distinguishing a monoamide from a diamide, by M. Gal.—On a process of hardening soft calcareous stones by means of fluosilicates with a base of insoluble oxides, by M. Kessler.—On a means of foreseeing liberations of firedamp, by M. de Chancourtois. On the supposition that movements of the earth's crust often cause such liberation, he proposes the use of delicate seismographic apparatus.—New histological researches on the termination of the biliary conduits in the lobules of the liver, by M. Kanellis.—On the structure of the nervous system of Hirudineæ, by M. Saint Loup.—On the incubation of eggs of a hen affected by cholera of fowls, by M. Barthélemy. The eggs contained germs of the microbes; these were only developed with aërial respiration when the allantoid yielded to the blood the oxygen necessary. (The development of the embryo stopped between the eighth and the tenth day.)—Comparison between the bacilli of tuberculosis and of leprosy (continued), by M. Babes.—M. Common presented a negative photograph of the nebula in Orion (taken January 30). An equatorial reflector of three feet aperture was used, and the dry plate was exposed 39 minutes.

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